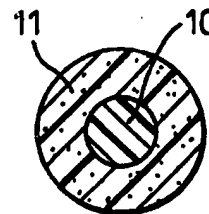


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(54) Title: GEL SEALING ARTICLES (57) Abstract Gel sealing profiles with various forms of solid carrier, including filaments and fixing lug (preferably integral with carrier) with enlarged head for snap or slide fitting into slot to hold profile on surface to be sealed; uses as door or window seal, bath or basin seal, and condensation diverter are specified. Also covers plastics-coated glass filament carriers, spring carriers (solid or hollow gel), metal wire "dead bend" carriers, optical fibre carriers, and braid knit, weave or other fabric carriers of natural or synthetic plastics or metal. The carrier may be recessed within the gel for enhanced end-to-end sealing of the profiles in grooves, e.g. in automotive headlamp units. Separately claimed are hollow tubular gel profiles omitting any hollow or solid carrier altogether.		



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GEL SEALING ARTICLES

This invention relates to elongate gel-carrying articles (hereinafter "gel profiles") of various cross-sectional shapes, which may be useful in a wide variety of circumstances for sealing against and/or between surfaces. For avoidance of doubt, it is hereby confirmed that the claims to all articles of this invention relate to free-standing articles carrying the gel and are intended to exclude elongate components such as wires in a gel-containing cable or other assembly. Such components are in contact with the gel only as a result of being in that assembly and are therefore not free-standing gel profiles. It will be understood that the filamentary carrier of those free-standing profiles will often be a relatively narrow monofilament or a multi-filament yarn, preferably of diameter less than 3 mm, more preferably less than 2 mm or less than 1 mm. However, thicker carriers, for example of diameter 4 or 5 mm or more, possibly having more rod-like characteristics of stiffness, may also be useful, as may be flexible carriers of this diameter made up of multiples of thinner carriers. The profiles are generally preferred to be flexible and may be provided in coil or roll form from which the profile can be progressively unwound. In such coils or rolls, the gel of the profiles in each succeeding layer may be in direct contact with that of the underlying layer, or a low-adhesion release sheet or other barrier may be incorporated between the layers of gel profile.

Our co-pending International Patent Application WO-A-9609483 (RK508) describes and claims elongate sealing members carrying a tubular body of gel sealant material on a gas-containing carrier. The gel profiles of the present invention have different forms providing other and/or additional advantages and uses.

One aspect of the present invention provides an article comprising an elongate filamentary carrier carrying an elongate body of gel which encloses at least 50%, preferably more than 75%, more preferably substantially all, of the perimeter of the carrier as viewed in transverse cross-section.

It will be understood that the reference to the view of the carrier in transverse cross-section means that the gel encloses the stated proportions of the perimeter of the

carrier as viewed from an end of the article looking along its longitudinal axis. The perimeter enclosed by the gel is thus the perimeter of the cross-section. Substantially complete enclosure of that perimeter of the carrier by the gel is advantageous for many purposes, and may obviate the need for the gel to adhere, or at least to adhere strongly, to the carrier, since the cohesive strength of the gel surrounding the carrier may be sufficient to retain it in on the carrier without such adhesion. For other purposes, however, partial enclosure of the carrier by the gel may be preferable, for example when the carrier has a projection for fastening it to other objects as hereinafter described.

The cross-sectional shape of the carrier and that of the gel are not critical for the purposes of this invention. Square, triangular or other shapes, or even irregular shapes, may be used for the carrier and/or the gel if desired or necessary, but substantially oval or round cross-sectional shapes will often be preferable for either the carrier or the body of gel or both. Whatever the shape, it will usually be preferable for the cross-sectional shape of the body of gel to be substantially uniform along the article, which may thus resemble a string or cord or rod having an outer surface of gel. It is also usually preferable for the thickness of the body of gel to be substantially uniform around the carrier, thus forming a layer of gel which conforms to the exterior shape of the carrier.

For many purposes, it may be preferable that the carrier is a mono-filament of glass or plastics material, the term "plastics" being used loosely to include both natural and synthetic polymeric materials. Multi-filament yarns, for example spun yarns, may also be useful. The gel may be applied to the carrier by any convenient method, and preferred articles according to this aspect of the invention are those wherein the body of gel has been melt-coated, preferably extruded, around the carrier. In all aspects of this invention, the gel may be cross-linked after placement on the carrier, although thermoplastic gels on the carrier may be preferable for many purposes.

Articles according to this first aspect of the invention may be useful, for example, for winding around other objects to provide a gel surface thereon, or for laying along surfaces of articles or in channels formed in articles to provide a gel sealant on or in

those articles for sealing against other surfaces with which the articles will be in contact in use.

Especially preferred articles according to the various aspects of this invention are those wherein the gel comprises a thermoplastic triblock copolymer having a fluid-extended elastomeric mid-block and having end blocks (preferably polystyrene or polymethacrylate end blocks) which are substantially impervious to the extender liquid of the mid-block, and the carrier is of plastics material, preferably comprising ethylene/vinylacetate copolymer as a majority by weight of the polymer content.

The triblock copolymer gels will preferably have the characteristics and meet the criteria described in any or all of EP-A-0426658 (RK308), WO-A-9305113 (RK451), WO-A-9323472 (RK469), and WO-A-9418273 (RK472), the disclosures of all of which are incorporated herein by reference. Those disclosures deal mainly or wholly with triblocks having polystyrene end blocks. For higher temperature performance, it may be preferable to use the new triblock gels having polyalkylmethacrylate end blocks described in our co-pending International Patent Application PCT/GB96/01381 (RK509), the disclosure of which is incorporated herein by reference.

In most forms of the various aspects of this invention, it will be preferable that the carrier(s) is(are) substantially continuous and substantially free of voids (meaning random or unintended voids, not the aforementioned deliberately-formed through-holes). Preferred forms of the articles for certain purposes are those wherein the carrier includes a formation, preferably integral with the carrier, for attaching the carrier to an object which is to carry the article in use. In these cases, although the carrier and the attaching formation could be completely enclosed by a coating of gel, it will frequently be preferable that the gel encloses only the part of the carrier constituting its main body, which in use will perform the sealing function, leaving the attaching formation free of gel. Thus, the partial enclosure of the carrier by the gel hereinbefore referred to may be preferred in these cases. The attaching formation may take any appropriate form, one preferred form being a projection having an enlarged region receivable in use in the aperture in the said object to anchor the carrier thereto. The attaching formations need

not be, but preferably are, integral with the carrier, the carrier and attaching formation preferably being moulded or extruded or otherwise formed as one piece. Hooks or other convenient formations may be used for the attaching formation as desired, but the aforementioned projections with enlarged regions will often be convenient in use, especially those having an enlarged "head" which may be snap-fitted or slid into a slot in the object to which the article is to be attached.

In this connection, a second aspect of the invention provides an article comprising an elongate (preferably rod-like) carrier carrying an elongate body of gel and including a formation, preferably integral with the carrier, for attaching the carrier to an object which is to carry the article in use. Thus, relatively thick, rod-like carriers may be used, which may perhaps be regarded as unusually thick mono-filaments in the first embodiment of the invention hereinbefore described. Partial enclosure of the carrier by the gel may again be convenient as aforesaid.

These attachable aspects of the invention may provide articles which are especially suitable for long seals attached, for example, to objects such as windows or doors to provide seals at the closure interface, for example between the window and its casement. This may be particularly advantageous in double glazing constructions. The attaching projection or "lug" will often extend all the way along the carrier, but may if preferred be formed only at intervals along it.

It will be appreciated that, instead of having an identifiable attaching formation as described above, the sealing profiles according to this invention could simply be shaped as a whole and accommodated in a slot or aperture of appropriate shape to enable part of the profile to project for sealing purposes. Whatever the form of profile selected, the cohesive strength, flexibility, and sealing characteristics of gels, especially the preferred gels hereinbefore mentioned, may be highly advantageous in circumstances requiring frequent re-opening and re-closing of the seals, for example doors and windows aforesaid.

Specific embodiments of the aforementioned aspects of this invention will now be described in more detail by way of example, with reference to the accompanying schematic drawings wherein :-

Figure 1 shows an end view of a profile comprising a mono-filament carrier completely enclosed by gel;

Figure 2 shows a mono-filament profile similar to that of Figure 1 with the addition of an arrow-headed projecting formation fixing the profile in a channel between two sealing surfaces; and

Figure 3 shows a profile comprising a generally triangular rod-like carrier completely enclosed by gel positioned in a groove shaped to retain the profile in one of a pair of sealing surfaces with part of the profile projecting from the groove to perform the sealing function.

Referring to Figure 1, a substantially round mono-filament carrier 10 of extruded ethylene/vinylacetate copolymer (known per se) carries a co-extruded coating 11 of a 6% triblock copolymer gel composition of the kind described in the aforementioned publications. The gel may be co-extruded onto the fibre or may be melt-coated onto a previously formed fibre. Suitable equipment and operating conditions can be selected without further instruction by those skilled in this field of technology, for example with the fibre-forming polymer being extruded from the main barrel of a cross-head extruder and the oil-extended triblock copolymer being melted in the cross-head and applied as an outer extruded envelope around the progressively-forming fibre.

Figure 2 shows another form of profile in which the gel 61 adheres to a carrier 60 having an arrow-headed fixing lug 62 engaged in slot 63 of a first body 64 mateable with a second body 65 so that the sealing article can perform its sealing function. The mateable bodies 64 and 65 may for example be protective housing parts for enclosing electrical or other equipment, for example wire or cable joints, optical fibre joints, or gas meter working parts, or may be door or window closure members as hereinbefore mentioned. The materials for the carrier and gel may be selected for convenient manufacture and to suit the end uses in question, the gel preferably adhering reasonably strongly to the carrier in this form of article.

In Figure 3, the triangular rod-like carrier 70, completely enclosed by gel 71 has been forced-fitted or longitudinally slid into groove 72 formed in one of a pair of mating bodies 73, 74 (for example protective housings or closure members as aforesaid). A portion 75 of the more-or-less triangular profile projects from the groove 72 so as to form a gel seal against the mating surface 74 in use. The groove 72 has been shaped as shown to allow space for distortion of the profile under sealing pressure.

For all aspects of this invention, the gel may in principle be extruded onto the carrier in a manner similar to that described with reference to Figure 1, with suitable modifications of the extrusion heads as will be apparent to persons skilled in such matters.

A third aspect of the present invention provides the gel profiles comprising gel carried on an elongate carrier of sufficient flexibility to enable the article to be wound at least 90° , preferably 180° , around a circular shaft of diameter 100 cm, preferably 50 cm, more preferably 25 cm, especially 10 cm, without breaking the carrier. Various materials and forms of carrier will meet these criteria, one preferred variant using a carrier comprising a filament or yarn, preferably of glass, coated with plastics material of lower Young's modulus and/or higher elongation to break than the said filament or yarn. In such variants, it may be preferred that the carrier is a glass monofilament or multi-filament yarn coated with a polyolefin, preferably low-density polyethylene. For glass and/or other carrier materials, it may be preferred that the plastics material with which the filament or yarn is coated is one to which the gel adheres more strongly than the gel adheres to itself on surface-to-surface contact. The aforementioned low-density polyethylenes, especially after adhesion-enhancing surface treatments of known kind, tend to satisfy this criterion for known oil-extended thermoplastic elastomer triblock copolymer gels (hereinafter triblock copolymer gels) such as those described in the published or co-pending documents referred to in the aforementioned co-pending application No. 9516960.3. The articles according to this third aspect of the present invention are preferably made by feeding the carrier through an extrusion cross-head which melt extrudes the gel onto the carrier in known manner.

A fourth aspect of the present invention provides the gel profiles wherein the carrier comprises a spring, preferably a coil spring. The spring may be straight or bowed, eg. in the form of an uncoiled wire or leaf spring, but coil springs may be preferred for many purposes, for example where their longitudinal extensibility and/or lateral flexibility is useful. It may be desirable in some cases that the carrier is a coil spring and is embedded and enclosed in a solid body of the gel which substantially fills the interior space of the coil. Alternatively, it may be preferred that the carrier is a coil spring and is enclosed by a hollow tube of the gel, in which case it may be that the spring is at least partly embedded within the wall of the gel tube. However the spring need not be embedded in the gel wall of the tube, which may instead be like a skin around the outer surfaces of the spring without the spring intruding to any significant extent into the (preferably uniform) thickness of the gel wall. All these spring profiles have the advantage that the spring may be deformed to keep the gel under compression to enhance the profile's sealing function in use. While springs made of plastics or other materials may be useful in some cases, it will often be preferable for the spring (of whatever form) to be made of metal, with or without a coating thereon. This coating may be of another metal, e.g. cadmium or zinc to prevent corrosion, or of plastic or other flexible material either to prevent corrosion or to increase the diameter of the metal so that it imposes less pressure on the gel and reduces the propensity to cut through it, without increasing the strength of the spring, or both. These spring profiles may be made by moulding the gel around suitably short lengths of the spring carriers or by extruding it around longer carrier lengths fed through a suitable cross-head extrusion die.

In a fifth aspect of the present invention the carrier of the gel profile is a metal wire, with or without a plastics or metal coating thereon. Preferably the bend modulus of the wire is sufficiently low for the article to be permanently bent without causing the wire to protrude through the gel. The elongation of the gel will usually be more than sufficient to accommodate such bending of the wire without cracking of the gel. Suitable bend modulus of the wire is readily determined by testing whether the wire tends to cut through the gel at the points where bending pressure is applied, any wire which does so preferably being rejected as too stiff for the selected gel. The permanent bending of the

wire enables this form of profile to hold an imposed bent shape without any unacceptable tendency to spring back into its undeformed shape or another undesired shape. These profiles may be made by continuous cross-head extrusion of a thermoplastic gel onto the selected wire, or by moulding the gel onto shorter lengths of wire in suitable moulds.

In a sixth aspect of the present invention, the carrier of the profile is a coated or uncoated stranded metal wire or rope, and in a seventh aspect, the carrier is a coated or uncoated braid, knit, weave, or other fabric-like assembly of plastics or metal filaments. These forms of article may again be made by extrusion or moulding techniques similar to those referred to above.

Further aspects of the present invention provide ingenious new uses of self-anchoring profiles of the kind hereinbefore described or the similar self-anchoring profiles described in co-pending International Patent Application WO-A-9609483 (RK508), see especially Figure 17, in which the carrier is a gas-containing, preferably tubular, carrier. Thus, an eighth aspect of the invention provides the self-anchoring profiles acting as a bath seal or wash-basin seal; and a ninth aspect of the invention provides use of the same self-anchoring profiles as a barrier to prevent moisture or other fluid from running down a sloping or vertical surface.

These eighth and ninth aspects of the invention are further illustrated by the accompanying drawings, wherein :-

Figure 4 shows schematically a self-anchoring profile wash-basin seal, and Figure 5 shows schematically a self-anchoring profile condensation barrier.

Referring to Figure 4, part of a wash-basin 10 is shown mounted in the usual aperture in a bench top 12, with a lip 14 of the basin projecting outwards across the bench top. Within the lip 14 is a tubular gel profile 16 having a hollow tubular (in this example, but could be solid) carrier 18 attached to the bench top by integral securing lug 20 extending through a hole 22 in the bench top. The gel profile, as is preferred, is wide enough to exclude water from the hole 22 in the event of water coming under the lip 14. The profile also prevents such water from running down between the bench top

and the upright side of the wash-basin 10. The self-anchoring profile has the advantage of resisting the tendency to creep out of position which can be a problem with known injected sealing compounds.

Figure 5 shows schematically part of a car door 30 having an interior trim panel 32 attached by means of the usual metal spring clips 34 snap-fitted into apertures 36 in the painted metal door body. Vibrational movement of the clips 34 during the service life of the car tends to remove paint from around the apertures 36, thus exposing the underlying metal, which begins to corrode when condensation 37 runs down the inside of the door body beneath the trim panel 32 and reaches the exposed metal around the apertures 36. This problem may be addressed by securing a gel profile 38 having a solid (in this example) carrier with attached securing lug 40 in suitable securing holes above those (36) of the trim panel, so as to intercept the condensation and divert it outwards away from the line of trim-securing holes 36. This diverting effect may be enhanced by sloping or curving the gel profile, for example as shown by broken lines 38'. The diameter of the gel profile 38 is wide enough to protect its own securing holes from the condensation, in a manner similar to that illustrated for the wash-basin of Fig. 4. This aspect of the invention could also be applied to prevention of corrosion of e.g. car door panels under external trim such as elastomeric bars applied to prevent damage to the door panel when hit by the opening doors of other vehicles.

A tenth aspect of the invention provides that the carrier may be an optical fibre, the cushioning effect of the gel coating on such a fibre being advantageous, especially in environments where the fibre is subjected to vibration or other stresses which can be absorbed by the gel. The cladding or other outer surface presented by the optical fibre will be selected to have no unacceptable degree of interaction with the gel materials, preferably being substantially impervious to the preferred gel-forming oils and polymers.

For some purposes, it may also be useful to provide, as an eleventh aspect of the invention, gel profiles comprising a hollow tube of gel, preferably corresponding to those hereinbefore described or those described in International Patent Application WO-A-9609483 (RK508), having no supporting carrier at all. Such gel-only tube profiles

will preferably be made of gel having sufficient rigidity to retain its open tube cross-sectional shape, depending on the tube diameter and wall thickness chosen for any specific example. It will be understood, therefore, that the rigidity of the gel will need to be higher for tubes of larger diameters and/or thinner walls. Suitable gels may readily be selected by simple trial and error, one possibly preferred kind of gel being the known oil-extended triblock copolymer gels comprising at least 15% by weight, based on the weight of the whole gel composition, of a styrene-hydrogenated alkylene-styrene triblock copolymer, which are described for example in EP-A-0426658 (RK308), WO-A-9305113 (RK451), WO-A-9323472 (RK469), and WO-A-9418273 (RK472), the disclosures of all of which are incorporated herein by reference. Such gels comprising at least 20%, and preferably not more than 35%, more preferably not more than 30%, of the triblock copolymer, with the proportion of extender oil preferably within the range from 80% to 65% by weight of the whole gel composition, may be especially useful for the unsupported gel tube profiles. Hollow gel tubes of thermoplastic gels may be formed by known melt extrusion using a tube-forming extrusion die with sufficient internal gas pressure to maintain the tubular form until the extrudate has sufficiently cooled.

In a twelfth aspect of the present invention, the carrier may be recessed within one or both ends of the gel carried by an article as hereinbefore described or the aforementioned similar articles described in WO-A-9609483. This recessing of the carrier enables the article(s) to be butt-joined end-to-end, with more effective end-sealing compression than would be achieved when the carrier ends flush with the end of the gel. The recessing of the carrier may be effected by any convenient method, for example by pushing back the gel, cutting off a short length of the carrier, and returning the gel to extend past the cut end of the carrier. As an alternative, the carrier could be recessed within the gel at one of the abutting ends and caused to project from the gel at the other end, so that the projecting length of carrier can be inserted into a recessed end to form an interlocking butt joint.

Articles thus recessed, at one or preferably both abutting ends, may be advantageous for effective sealing in an annular channel such as a headlamp housing or

equipment housing, for example as described in the aforementioned WO-A-9609483, the disclosure of which is incorporated herein by reference.

This twelfth aspect of the invention is further illustrated in schematic cross-sectional side view in Figure 6 of the accompanying drawings, wherein Fig. 6A shows the opposed ends of an article according to the invention wherein the carrier 40 has been trimmed back at one end to form a recess 42 within the gel 44, while the carrier 40 at the other end of the article is flush with the end of the gel 44. Figure 6B shows a similar arrangement, wherein the carrier has been cut back to form recesses 42 at both ends of the article. Figure 6C shows a similar arrangement wherein the carrier has been cut back as before to form recess 42 at one end of the article, while the gel has been cut back to expose a projecting part 46 of the carrier at the other end of the article. As illustrated, the recess 42 in this arrangement is slightly longer than the projection 46 to allow for desirable sealing gel-to-gel compression when the projection 46 is inserted into recess 42.

In all aspects of the present invention, the gels may include additives such as cross-linking agents. Fillers and additives may also be used to increase the electrical and/or thermal conductivity of the gels, or to enhance the noise or vibration-absorbing qualities of the gels. Flame retardants, pigments, dyes, and other additives may also be used as desired, if compatible with the desired end-use properties of the gels. The gel surface may be selectively cross-linked, preferably using known cross-linking additives and/or initiators and/or heat and/or UV or electron beam radiation, to form a skin on desired parts of the gel bodies, either to reduce surface adhesion, or to enhance the strength and/or handleability of the gel bodies, or both.

CLAIMS

1. An article comprising an elongate filamentary or rod-like carrier carrying an elongate body of gel which encloses more than 50%, preferably more than 75%, more preferably substantially all, of the perimeter of the carrier as viewed in transverse cross-section.
2. An article according to claim 1, wherein either the carrier, or the body of gel, or both, has or have a substantially oval or round cross-sectional shape.
3. An article according to claim 1 or 2, wherein the carrier is a mono-filament of glass or natural or synthetic plastics material, or an optical fibre
4. An article according to any preceding claim, wherein the gel, at least as initially applied to the carrier, is thermoplastic.
5. An article according to claim 4, wherein the body of gel has been melt-coated, preferably extruded, around the carrier.
6. An article according to any preceding claim, wherein the gel has been cross-linked after placement on the carrier.
7. An article according to any preceding claim, wherein the gel comprises a thermoplastic triblock copolymer having a fluid-extended elastomeric mid-block and having end blocks (preferably polystyrene or polymethacrylate end blocks) which are substantially impervious to the extender liquid of the mid-block.
8. An article according to any preceding claim, wherein the carrier is substantially continuous and substantially free of voids.

9. An article according to any preceding claim, wherein the cross-sectional shape of the body of gel is substantially uniform along the article and/or the thickness of the body of gel is substantially uniform around the carrier.
10. An article according to any preceding claim, wherein the carrier includes a formation, preferably integral with the carrier, for attaching the carrier to an object which is to carry the article in use.
11. An article comprising an elongate (preferably rod-like) carrier carrying an elongate body of gel and including a formation, preferably integral with the carrier, for attaching the carrier to an object which is to carry the article in use.
12. An article according to claim 10 or 11, wherein the said formation comprises a (preferably lateral) projection with an enlarged region receivable in use in an aperture in the said object to anchor the carrier thereto.
13. An article according to any preceding claim in use as a door or window seal.
14. An article according to any preceding claim, comprising gel carried on an elongate carrier of sufficient flexibility to enable the article to be wound at least 90° , preferably 180° , around a circular shaft of diameter 100 cm, preferably 50 cm, more preferably 25 cm, especially 10 cm, without breaking the carrier.
15. An article according to any preceding claim, wherein the carrier comprises a filament or yarn, preferably of glass, coated with plastics material of lower Young's modulus and/or higher elongation to break than the said filament or yarn.
16. An article according to claim 15, wherein the carrier is a glass monofilament or multi-filament yarn coated with a polyolefin, preferably low-density polyethylene.

17. An article according to claim 15 or 16, wherein the plastics material with which the filament or yarn is coated is one to which the gel adheres more strongly than the gel adheres to itself on surface-to-surface contact.
18. An article according to any of claims 1, 2, and 4 to 12 when not dependent on claim 3, wherein the carrier comprises a spring, preferably a coil spring.
19. An article according to claim 18, wherein the carrier is a coil spring and is embedded and enclosed in a solid body of the gel which substantially fills the interior space of the coil.
20. An article according to claim 18, wherein the carrier is a coil spring and is enclosed by a hollow tube of the gel.
21. An article according to claim 20, wherein the spring is at least partly embedded within the wall of the gel tube.
22. An article according to any of claims 18 to 21, wherein the spring is made of metal.
23. An article according to any of claims 1, 2, and 4 to 12 when not dependent on claim 3, wherein the carrier is a metal wire, with or without a plastics coating thereon.
24. An article according to claim 23, wherein the bend modulus of the wire is sufficiently low for the article to be permanently bent without causing the wire to protrude through the gel.
25. An article according to any of claims 1, 2, and 4 to 12 when not dependent on claim 3, wherein the carrier is stranded metal wire or rope.

26. An article according to any of claims 1, 2, and 4 to 12 when not dependent on claim 3, wherein the carrier is a braid, knit, weave or other fabric-like assembly of natural, plastics, or metal filaments.
27. An article according to any of claims 10 to 12 or a similar article in which the carrier is a gas-containing, preferably tubular, carrier, which article is in use as a bath seal or wash-basin seal, or in use as a barrier to prevent moisture or other fluid from running down a sloping or vertical surface.
28. A hollow tube of gel, preferably corresponding to those described for the article according to any of claims 1, 2, 4 to 7, and 9, or a similar article in which the carrier is a gas-containing, preferably tubular, carrier, the hollow tube of gel having no supporting carrier.
29. An optical fibre carrying a layer of gel, the layer of gel preferably having substantially uniform thickness around the fibre and/or preferably having substantially uniform cross-sectional shape along the fibre.

Fig.1.

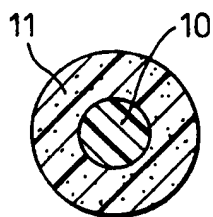


Fig.2.

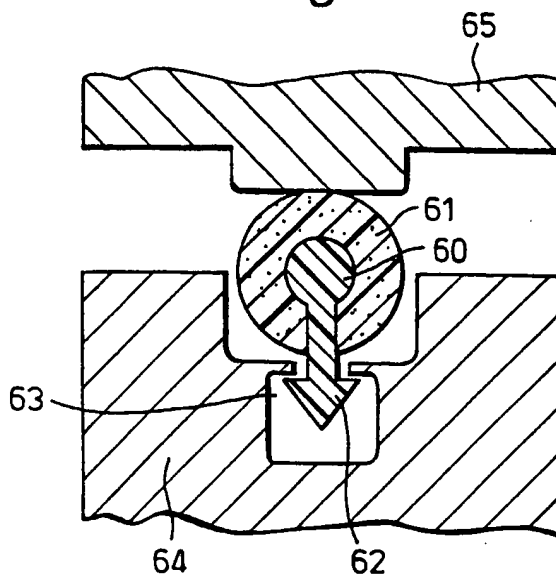


Fig.3.

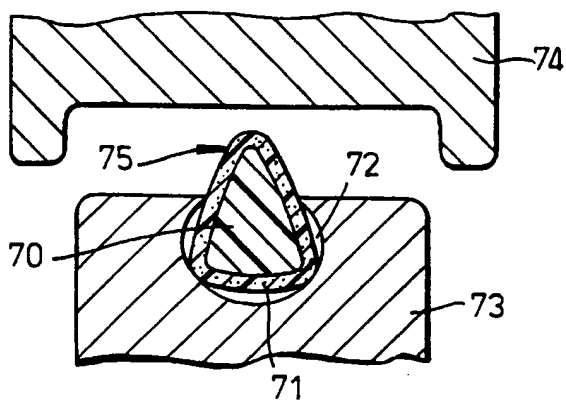


Fig.4.

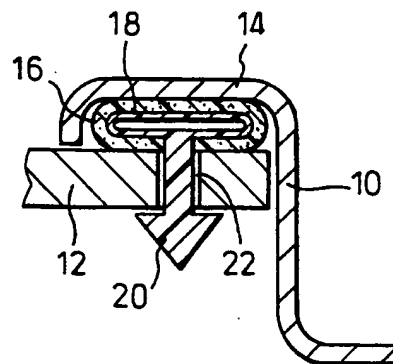


Fig.5A.

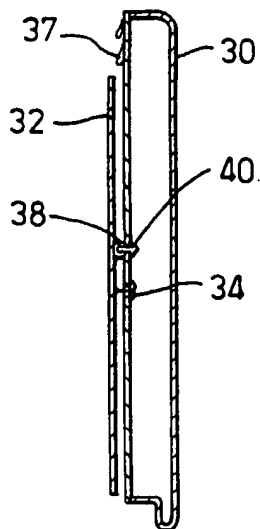


Fig.5B.

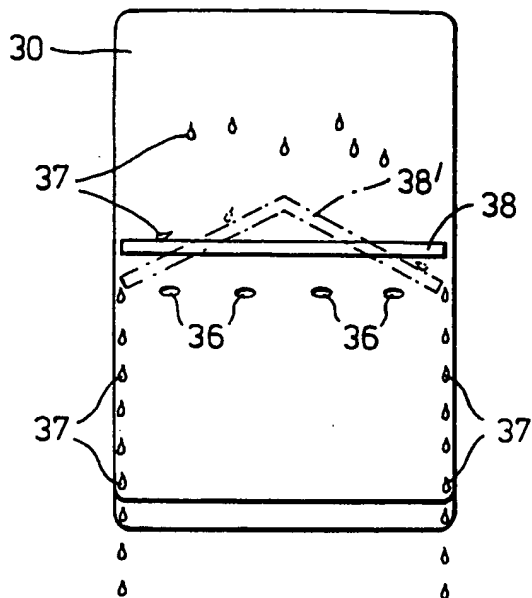


Fig.6A.

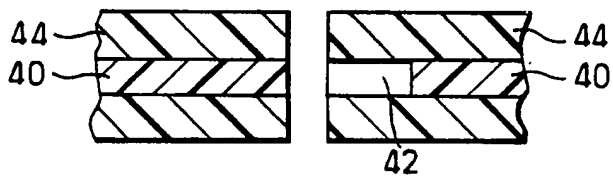


Fig.6B.

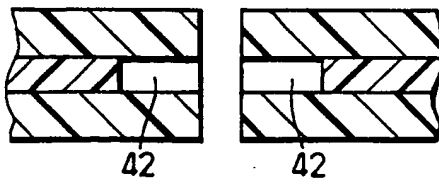
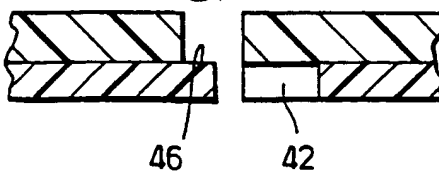


Fig.6C.



SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/02000

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F16J15/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F16J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	WO,A,96 09483 (RAYCHEM) 28 March 1996 see claims; figures ---	1-5,7, 9-14,17, 28
X	PATENT ABSTRACTS OF JAPAN vol. 8, no. 26 (M-273), 3 March 1984 & JP,A,58 184361 (NISSAN), 27 October 1983, see abstract ---	1,2
A	WO,A,94 05935 (RAYCHEM) 17 March 1994 see abstract; figures ---	1,7-9,11
A	EP,A,0 275 171 (RAYCHEM) 20 July 1988 see abstract; figures 1A-1D -----	1,25,26

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

21 November 1996

Date of mailing of the international search report

03.12.96

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Narminio, A

INTERNATIONAL SEARCH REPORT

information on patent family members

Int: Int Application No

PCT/GB 96/02000

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